Sixth Semester B Tech Degree Examination, May 2016

(2013 Scheme)

13.603 : CONTROL SYSTEMS (T)

Time : 3 Hours   Max. Marks : 100

PART – A

*(Answer **all** questions. Each carries **2** marks)*

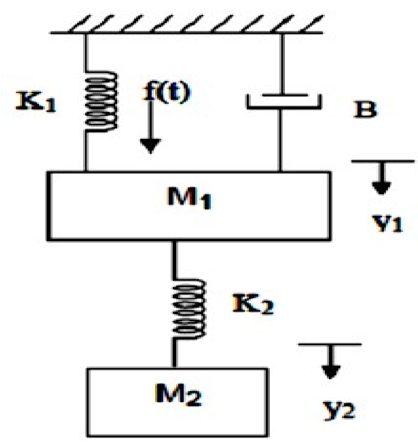
1. What is a closed loop control system?
2. State Mason's gain formula and explain each term.
3. Find the transfer function of a system described by $4\frac{d^2y}{dx^2}+3\frac{dy}{dx}+2y=\frac{d^2x}{dt^2}+6x$.
4. Define the terms type and order of a control system.
5. What is transient and steady state response?
6. Define rise time and peak time.
7. Define gain margin and phase margin.
8. Explain Nyquist's stability criteria.
9. Compare lag and lead compensation.
10. State Kalman's method of testing controllability and observability. (10 X 2)

PART – B

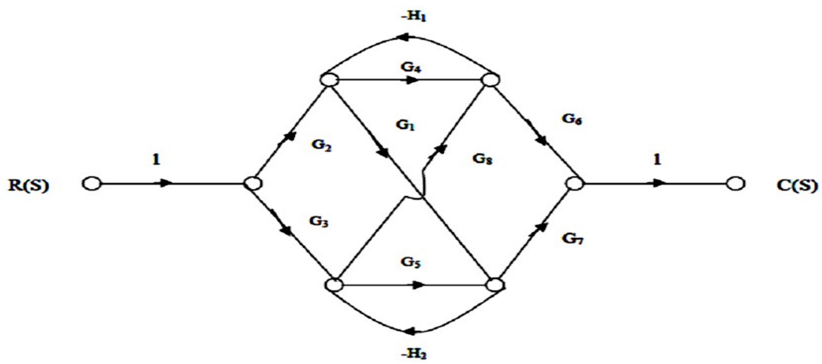
(Answer any one question from each module. Each carries 20 marks)

Module I

11(a) Determine the transfer function Y2(S)/F(S) of the system shown in figure (7)

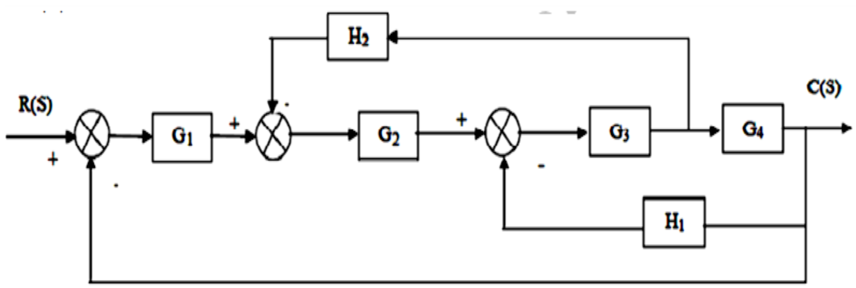


(b) Find the overall gain of the system whose signal flow graph is shown in figure (13)



12(a) Derive the transfer function of an armature controlled DC motor (10)

(b) Determine the overall transfer function C(S)/R(S) for the system shown in figure (10)



Module II

13(a) What are Time domain specifications? Derive them for a second order system (10)

(b) The open loop transfer function of a unity feedback system is given by

$G(s) = \frac{K}{s(sT+1)}$ where K and T are positive constants. By what factor should the amplifier gain K be reduced, so that the peak overshoot of unit step response of the system is reduced from 75% to 50%. (10)

14(a) For a unity feedback control system the open loop transfer function $G(s) = \frac{10(s+2)}{s^2\,(s+2)}$. Find

(i) the position, velocity and acceleration error constants

(ii) the steady state error when the input is $R(s) = \frac{3}{s} - \frac{2}{s^2} + \frac{1}{3s^3}$ (10)

(b) Construct Routh array and determine the stability of the system represented by the characteristic equation $s^5 + s^4 + 2s^3 + 2s^2 + 3s + 5 = 0$. Comment on the location of the roots of characteristic equation (10)

Module III

15(a) Sketch the Bode plot for the following transfer function and determine the system gain for K for the gain cross over frequency to be 5 rad/sec. G(s) = $\frac{Ks^2}{(1+0.2s)(1+0.02s)}$ (10)

(b) Sketch the Nyquist plot for the transfer function G(s) = $\frac{10}{s(1+s)(1+0.05s)}$. Assess the stability (10)

16(a) Explain the procedure for constructing root locus (10)

(b) A unity feedback control system has an open loop transfer function $G(s) = \frac{K}{s(s^2+4s+13)}$.

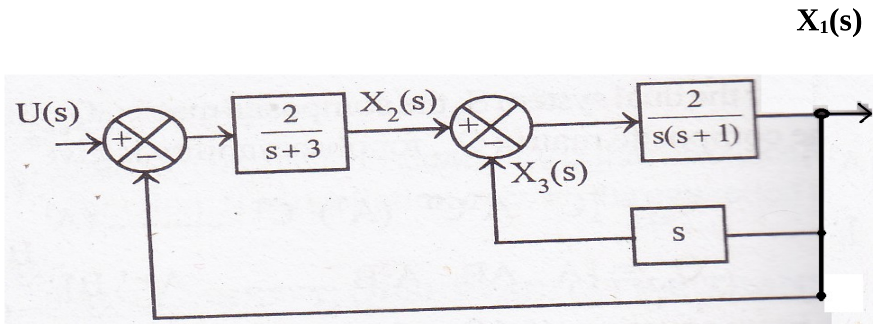
Sketch the root locus.

Module IV

17(a) Design a phase lead compensator for the system with an open loop transfer function $G(s) = \frac{K}{s^2(1+0.1s)}$ for the specifications of $K_a = 10$ and $\phi_{pm} = 30^o$ (10)

(b) A unity feedback control system has the transfer function G(s) = $\frac{10}{s(s+1)(s+3)}$. Design a PD controller so as to have a phase margin of 40^o at a frequency of 2 rad/sec.

18 Write the state equations for the system shown in figure in which x_1, x_2 and x_3 constitute the state vector. Determine whether the system is completely controllable and observable. (20)



X1(s)
U(s)
+
−
2
s+3
X2(s)
+
−
2
s(s+1)
X3(s)
s